

CECW-ET

Manual  
No. 1110-2-501

1 February 1999

**Design, Construction, and Operation  
SMALL WASTEWATER SYSTEMS**

**Table of Contents**

Subject	Paragraph	Page
<b>Chapter 1</b>		
<b>Introduction</b>		
Purpose .....	1-1	1-1
Applicability .....	1-2	1-1
References .....	1-3	1-1
Distribution Statement .....	1-4	1-1
Laws and Regulations .....	1-5	1-1
<b>Chapter 2</b>		
<b>Preliminary Data Requirements</b>		
General .....	2-1	2-1
Recreational Facilities .....	2-2	2-1
Determination of Effluent Limitations .....	2-3	2-1
Site Selection Factors .....	2-4	2-2
<b>Chapter 3</b>		
<b>Wastewater Generation and Characterization</b>		
General .....	3-1	3-1
Visitation and Length of Stay .....	3-2	3-1
Variations in Visitation .....	3-3	3-1
Water Usage and Wastewater Generation .....	3-4	3-1
Monthly and Daily Flow Distribution .....	3-5	3-2
Wastewater Characterization .....	3-6	3-3
<b>Chapter 4</b>		
<b>Collection Systems</b>		
General .....	4-1	4-1
Absence of Pressurized Water Supply .....	4-2	4-1
Transport by Truck .....	4-3	4-1
Gravity Flow Systems .....	4-4	4-3
Force Main Systems .....	4-5	4-3
Alternative Wastewater Collection Systems .....	4-6	4-4

Subject	Paragraph	Page
<b>Chapter 5</b>		
<b>Treatment Design Considerations</b>		
General .....	5-1	5-1
Small Individual Units .....	5-2	5-1
Conventional Wastewater Treatment Facilities .....	5-3	5-4
Stabilization Ponds .....	5-4	5-10
Natural Systems for Wastewater Treatment .....	5-5	5-11
Man-Made Wetlands .....	5-6	5-19
Nutrient Removal .....	5-7	5-23
Sludge Treatment and Disposal .....	5-8	5-25
Disinfection of Wastewater Effluents .....	5-9	5-28
<b>Chapter 6</b>		
<b>Laboratory Design, Sampling, and Flow Monitoring</b>		
General .....	6-1	6-1
Laboratory Design .....	6-2	6-1
Sampling and Analysis .....	6-3	6-2
Flow Monitoring .....	6-4	6-2
<b>Chapter 7</b>		
<b>Treatment Process Selection</b>		
Overview .....	7-1	7-1
Site Visitation .....	7-2	7-1
Local Resources .....	7-3	7-1
Economic Considerations .....	7-4	7-1
Health Considerations .....	7-5	7-3
Aesthetic Considerations .....	7-6	7-4
Safety Considerations .....	7-7	7-4
Access/Security Considerations .....	7-8	7-4
Comparison of Treatment Processes .....	7-9	7-5
<b>Chapter 8</b>		
<b>Design References and Examples</b>		
General .....	8-1	8-1
Military Design Manuals .....	8-2	8-1
National Small Flows Clearinghouse (NSFC) Publications .....	8-3	8-2
Wastewater Design Manuals and Texts .....	8-4	8-2
U.S. Environmental Protection Agency (EPA) .....	8-5	8-2
Wastewater Design Criteria and Example Matrices .....	8-6	8-3
Additional Design Examples .....	8-7	8-4
<b>Chapter 9</b>		
<b>General Wastewater System Design Deficiencies</b>		
General .....	9-1	9-1
Overall Considerations .....	9-2	9-1
Conventional Design .....	9-3	9-5
Preliminary Unit Processes .....	9-4	9-6

Subject	Paragraph	Page
Primary Treatment Unit Process . . . . .	9-5	9-10
Secondary Treatment Unit Processes . . . . .	9-6	9-11
Sludge Dewatering . . . . .	9-7	9-17
Non-Conventional Plants . . . . .	9-8	9-17
Land Application . . . . .	9-9	9-19
Sludge Drying and Disposal . . . . .	9-10	9-20
Sewer Collection Systems . . . . .	9-11	9-22
Lift Stations . . . . .	9-12	9-22

**Chapter 10**

**Sludge Disposal**

General . . . . .	10-1	10-1
Definitions . . . . .	10-2	10-1
Management Standards . . . . .	10-3	10-2
Toxic Metal Regulations . . . . .	10-4	10-2
Effect of Land Application . . . . .	10-5	10-2
Pathogen and Vector Attraction Reduction . . . . .	10-6	10-2
Exclusions . . . . .	10-7	10-3
Land Application Pollutant Limits . . . . .	10-8	10-3
Land Application Management Practices . . . . .	10-9	10-3
Surface Disposal Pollutant Limits . . . . .	10-10	10-4
Pathogens and Vector Attraction Reduction . . . . .	10-11	10-4
Pathogen Treatment Processes . . . . .	10-12	10-5
Septage Applied to Agricultural Land, Forests, or Reclamation Sites . . . . .	10-13	10-6
Wastewater Scum . . . . .	10-14	10-6
Composting Methods . . . . .	10-15	10-7
Composting Additives/Amendments/Bulking Agents . . . . .	10-16	10-7
Equipment . . . . .	10-17	10-7
Guidance . . . . .	10-18	10-10

**Appendix A**

**References**

**Appendix B**

**States with Regulations/Requirements Applicable to Small-Scale Wastewater Treatment Facilities**

**Appendix C**

**Wastewater Characterization Data**

**Appendix D**

**Wastewater Design Criteria and Examples Matrix Summary from Non-Military Sources**

**Appendix E**

**Design Examples**

**EM 1110-2-501**  
**1 Feb 99**

**Appendix F**  
**U.S. Army Experience with Natural Wastewater Treatment Systems**

**Appendix G**  
**Abbreviations and Glossary of Terms**